

WHAT IS CLAIMED IS:

1. An apparatus for determining a property of a subsurface formation, comprising:
an elongated body with tubular walls and a central bore, the body including at least
one slot formed therein such that the slot fully penetrates the tubular wall;
a support having a longitudinal axis, said support disposed within said central bore;
and
at least one antenna disposed on the support, said antenna being adapted to generate a
magnetic dipole moment with a transverse or controllable orientation;
wherein said antenna is positioned near the at least one slot.
2. The apparatus of claim 1, wherein said formation property is resistivity.
3. The apparatus of claim 1, wherein said at least one antenna is adapted to generate a
magnetic dipole moment oriented at an angle with respect to the longitudinal axis of
said support.
4. The apparatus of claim 1, wherein the elongated body is adapted at a first end for
connection to coiled tubing or to a tubular member.
5. The apparatus of claim 1, further comprising means to provide a pressure barrier
between the interior and exterior of the tubular wall at the at least one slot, the means
located within the central bore.
6. The apparatus of claim 5, wherein the means to provide a pressure barrier comprises a
sleeve.
7. The apparatus of claim 1, further comprising a shield disposed on the exterior of said
body to cover the at least one slot.
8. The apparatus of claim 7, wherein said shield is formed of a nonconductive material.

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- 2 9. The apparatus of claim 6, wherein said sleeve is formed of a material providing
- 3 transparency to electromagnetic energy.
- 4
- 5 10. The apparatus of claim 1, wherein the support includes connecting means at one end
- 6 thereof, the connecting means adapted to allow for retrieval of said support from
- 7 within said central bore.
- 8
- 9 11. The apparatus of claim 1, said support further comprising one of a permanent magnet
- 10 means, a gamma-ray source, or a neutron source.
- 11
- 12 12. The apparatus of claim 1, said support further comprising means for transmitting or
- 13 receiving a signal along said central bore.
- 14
- 15 13. The apparatus of claim 1, wherein the at least one antenna is covered by a shield
- 16 disposed on said support.
- 17
- 18 14. The apparatus of claim 1, wherein the at least one slot comprises an insert or filler
- 19 material disposed therein.
- 20
- 21 15. The apparatus of claim 1 wherein said at least one antenna comprises a saddle coil.
- 22
- 23 16. The apparatus of claim 1 wherein said at least one antenna comprises a coil assembly.
- 24
- 25 17. The apparatus of claim 16, wherein said coil assembly comprises a plurality of coils
- 26 having non-parallel axis.
- 27
- 28 18. The apparatus of claim 16, wherein said coil assembly comprises a tri-axial set of
- 29 coils.
- 30

- 1 19. The apparatus of claim 1, further comprising at least one antenna disposed on said
2 support with its magnetic moment parallel to the longitudinal axis of said support.
3
- 4 20. The apparatus of claim 3, wherein said support comprises a plurality of antennas
5 adapted to generate a magnetic dipole moment oriented at an angle with respect to the
6 longitudinal axis of said support.
7
- 8 21. The apparatus of claim 3, wherein said support comprises a plurality of antennas
9 adapted to generate a magnetic dipole moment oriented perpendicularly with respect
10 to the longitudinal axis of said support.
11
- 12 22. A method for determining a property of a subsurface formation, comprising:
13 a) disposing an elongated body within a borehole traversing said formation, said
14 body having tubular walls, a central bore, and including at least one slot formed
15 therein such that the slot fully penetrates the tubular wall;
16 b) disposing a support within the central bore of said body, said support having a
17 longitudinal axis and at least one antenna disposed thereon, said antenna being
18 adapted to generate a magnetic dipole moment with a transverse or controllable
19 orientation;
20 c) positioning said antenna near the at least one slot on said body; and
21 d) transmitting or receiving a signal with said at least one antenna to determine
22 said formation property.
23
- 24 23. The method of claim 22, wherein said formation property is resistivity.
25
- 26 24. The method of claim 22, wherein the signal of step (d) is transmitted or received as
27 the borehole is drilled through said formation.
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- 29 25. The method of claim 22, wherein step (a) comprises connecting said body to coiled
30 tubing or to a tubular member for disposal within said borehole.

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- 2 26. The method of claim 25, wherein said body is disposed within said borehole after the
- 3 borehole is drilled through said formation.
- 4
- 5 27. The method of claim 22, wherein the signal of step (d) is transmitted or received as
- 6 said body is extracted from said borehole.
- 7
- 8 28. The method of claim 22, wherein said at least one antenna is adapted to generate a
- 9 magnetic dipole moment oriented at an angle with respect to the longitudinal axis of
- 10 said support.
- 11
- 12 29. The method of claim 22, wherein said body comprises means to provide a pressure
- 13 barrier between the interior and exterior of the tubular wall at the at least one slot, the
- 14 means located within said central bore.
- 15
- 16 30. The method of claim 29, wherein the means to provide a pressure barrier comprises a
- 17 sleeve.
- 18
- 19 31. The method of claim 22, wherein said body comprises a shield disposed on its
- 20 exterior to cover the at least one slot.
- 21
- 22 32. The method of claim 31, wherein said shield is formed of a nonconductive material.
- 23
- 24 33. The method of claim 30, wherein said sleeve is formed of a material providing
- 25 transparency to electromagnetic energy.
- 26
- 27 34. The method of claim 22, wherein the support includes connecting means at one end
- 28 thereof, the connecting means adapted to allow for retrieval of said support from
- 29 within said central bore.
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- 1 35. The method of claim 22, wherein the support comprises one of a permanent magnet
2 means, a gamma-ray source, or a neutron source.
3
- 4 36. The method of claim 22, wherein the support comprises means for transmitting or
5 receiving a signal along said central bore.
6
- 7 37. The method of claim 22, wherein the at least one antenna is covered by a shield
8 disposed on said support.
9
- 10 38. The method of claim 22, wherein the at least one slot comprises an insert or filler
11 material disposed therein.
12
- 13 39. The method of claim 22, wherein said at least one antenna comprises a saddle coil.
14
- 15 40. The method of claim 22, wherein said at least one antenna comprises a coil assembly.
16
- 17 41. The method of claim 40, wherein said coil assembly comprises a plurality of coils
18 having non-parallel axis.
19
- 20 42. The method of claim 40, wherein said coil assembly comprises a tri-axial set of coils.
21
- 22 43. The method of claim 22, wherein said support comprises at least one antenna
23 disposed thereon with its axis parallel to the longitudinal axis of said support.
24
- 25 44. The method of claim 28, wherein said support comprises a plurality of antennas
26 adapted to generate a magnetic dipole moment oriented at an angle with respect to the
27 longitudinal axis of said support.
28

- 1 45. The method of claim 28, wherein said support comprises a plurality of antennas
2 adapted to generate a magnetic dipole moment oriented perpendicularly with respect
3 to the longitudinal axis of said support.
4
- 5 46. A system for determining a property of a subsurface formation, comprising:
6 a sub having an elongated body with tubular walls and a central bore, the sub being
7 adapted to form a portion of a length of drill string;
8 the sub having at least one slot formed therein such that the slot fully penetrates the
9 tubular wall;
10 a support member having at least one antenna disposed thereon, said antenna being
11 adapted to generate a magnetic dipole moment with a transverse or controllable
12 orientation;
13 the support member being adapted for transit through the drill string and into the
14 central bore of the sub; and
15 means for receiving the support member within the sub.
16
- 17 47. The system of claim 46, wherein said at least one antenna is adapted to generate a
18 magnetic dipole moment oriented at an angle with respect to the axis of said support
19 member.
20
- 21 48. The system of claim 46, further comprising means to provide a pressure barrier
22 between the interior and exterior of the sub wall at the at least one slot, the means
23 located within the central bore.
24
- 25 49. The system of claim 46, said support member further comprising one of a permanent
26 magnet means, a gamma-ray source, or a neutron source.
27
- 28 50. The system of claim 46, said support member further comprising means for
29 transmitting or receiving a signal along said central bore.